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Patent

VIBRATION BALANCED RECEIVER

Related Applications

This application is a continuation-in-part of U.S. Patent Application entitled, "Vibration Balanced Receiver," Serial No.09/479,134, filed January 7, 2000.

Technical Field

The present invention relates to receivers and more particularly to a vibration balanced receiver for a hearing aid.

Background of the Invention

Hearing aids have greatly contributed to the quality of life for those individuals with auditory problems. Technological advancements in this field continue to improve the reception, wearing comfort, life span and power efficiency of the hearing aid. In addition, several different hearing aid styles are available to choose from, i.e., behind the ear, in the ear, in the canal and completely in the canal.

The hearing aid is comprised of several components. One important component of the hearing aid is the receiver. The receiver is designed to utilize moving parts to generate acoustic energy in the ear canal of the individual using the hearing aid. Due to the motion of some of the parts within the receiver assembly, unintended vibrations may be transmitted through the receiver housing to the case of the hearing aid. In many situations, these vibrations are detrimental to the performance of the hearing aid.

The present invention is provided to solve these and other problems.

Summary of the Invention

Generally stated, this invention sets forth a method and an apparatus for reducing vibration in hearing aid receiver assemblies associated with the movement of the armature-diaphragm assembly and the resulting reactionary forces. It is an object of this invention to provide a balanced receiver with significantly reduced vibration.

In accordance with the present invention, the receiver comprises a closed loop having an opposing first and a second expanded regions. An armature is operably attached to the first expanded region and a diaphragm is operably attached to the second expanded region. An effective moving mass of the armature is substantially equal to an effective moving mass of the diaphragm.

Another aspect of the present invention described above further includes the closed loop having an opposing first and a second regions. A first portion of the closed loop is adjacent the first expanded region and the first region, a second portion of the closed loop is adjacent the first region and the second expanded region, a third portion of the closed loop is adjacent the second expanded region and the second region and a fourth portion of the closed loop is adjacent the second region and the first expanded region, wherein all four portions of the closed loop are of equal length.

Yet a further aspect of the present inventions described above comprises a quadrilateral for the closed loop. The armature is operably attached near the first expanded region; and the diaphragm is operably attached near the second expanded region.

According to another aspect, the present invention comprises an elliptical-like shaped spring having a first and a second axis. A diaphragm is operably attached to the elliptical-like shaped spring near the intersection of a distal end of the second axis of the elliptical-like shaped spring. An armature is operably attached to the elliptical-like shaped spring near a proximate end of the

second axis of the elliptical-like shaped spring. An effective moving mass of the armature is substantially equal to an effective moving mass of the diaphragm.

A further aspect of the invention involves a method of reducing the vibration of a receiver by providing an armature, a diaphragm and a closed loop having opposing first and second expanded regions. The armature is operably attached to the closed loop near a first expanded region and the diaphragm is operably attached to the closed loop near a second expanded region. The closed loop further having an opposing first and second regions, wherein the first and second regions are constrained from movement in a direction substantially parallel to an axis intersecting the opposing first and second expanded regions.

Yet another further aspect of the present invention involves a method of reducing the vibration of a receiver by providing an armature, a diaphragm and an elliptical-like shaped spring having a first and a second axis. The diaphragm is operably attached to the elliptical-like shaped spring near a distal end of the second axis of the elliptical-like shaped spring. The armature is operably attached to the elliptical-like shaped spring near the proximate end of the second axis of the elliptical-like shaped spring. The spring is constrained near a distal end of the first axis - a first region; and a proximate end of the first axis - a second region, wherein movement of the first and second regions in a direction parallel to the second axis is prevented.

Other advantages and aspects of the present invention will become apparent upon reading the following description of the drawings and detailed description of the invention.

Brief Description of the Drawings

FIGURE 1 is a perspective view of the receiver;

FIGURE 2 is a front view of the receiver of FIGURE 1;

FIGURE 3 is an alternative embodiment of the closed loop of FIGURE 1;

FIGURE 4 is a front view of an alternative embodiment of the present invention;

FIGURE 5 is a front view of an alternative embodiment of the present invention; and,

FIGURE 6 is a partial perspective view of a closed loop comprised of a strap.

Detailed Description of the Preferred Embodiment

While this invention is susceptible of embodiments in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

To improve the performance of a hearing aid, a receiver 10 can be designed to minimize or eliminate vibration within the receiver assembly. The receiver assembly 10 is illustrated in the Figures 1 and 2. The receiver 10 includes an armature 12 and a diaphragm 14. The armature 12 and the diaphragm 14 are both operably attached to a closed loop 16, preferably a pantograph. The closed loop 16, i.e., quadrilateral, serves as a connection between the diaphragm 14 and the armature 12. The quadrilateral structure 16 consists of an opposing first and second expanded regions 16a, 16b and an opposing first and second regions 16c, 16d. In addition to the regions 16a, (expanded) 16b, (expanded) 16c, 16d, there are four portions, or sides 16e, 16f, 16g, 16h. The first portion 16e is adjacent the first expanded region 16a and the first 16c region. The second portion 16f is adjacent the first region 16c and second expanded 16b region. The third portion 16g is adjacent the second expanded region 16b and the second region 16d. The

fourth portion 16h is adjacent the second region 16d and the first expanded 16a region. The armature 12 is operably attached to the quadrilateral structure 16 near the first expanded region 16a. The diaphragm 14 is operably attached to the quadrilateral structure 16 near the opposing expanded region 16b.

Alternatively, the structure of the closed loop 16 can be an elliptical-like shape and having an ellipticity of varying deviations. The elliptical-like shape comprising the structure of an elongated circle, oval, ellipse, hexagon, octagon or sphere.

The diaphragm 14 is preferably designed to have the same effective moving mass as the effective moving mass of the armature 12. Opposing regions 16c and 16d of the quadrilateral structure 16 are constrained by a bracket 18, thus preventing movement of the opposing regions 16c and 16d in a direction parallel to an axis (not shown) intersecting the opposing expanded regions 16a, 16b. Movement by the armature 12 is accompanied by an opposing movement of the diaphragm 14, thus the opposing motions of the armature 12 and diaphragm 14 work to effectively negate a relocation of the center of gravity within the receiver 10. A movement inward, toward the center of the closed loop 16, of the armature 12 causes an outward movement, away from the center of the closed loop, of the restrained regions 16c, 16d and thus, cause an inward movement of the diaphragm 14. Preferably, the four portions 16e, 16f, 16g, 16h are straight segments that allow for better transfer of motion through the quadrilateral structure 16.

FIGURE 6 depicts a partial view of the closed loop 16 as a strap having a thickness, T, ranging from 5×10^{-4} to 3×10^{-3} inch and a width, W, ranging from 10×10^{-3} to 20×10^{-3} inch. Preferably, the strap has a thickness of 5×10^{-4} inch and a width between 10×10^{-3} to 20×10^{-3} inch. Alternatively, the closed loop 16 can be comprised of a wire, e.g., stainless steel, etc., having a diameter ranging from 2.0×10^{-3} to 5.0×10^{-3} inch. The strap experiences less maximum stress during operation of the pantograph 16 as compared to the wire. Thus, the receiver 10 can be operated at a higher output before material fatigue becomes a concern.

Increasing or decreasing the motion transfer by the quadrilateral structure assembly 16 can be accomplished by varying the length of the first 16e and fourth 16h portions in relation to the length of the second 16f and third 16g portions. See Figure 3. For instance, increasing the length of the first 16e and fourth portion 16h to be equal to each other and greater then the length of the second 16f and third 16g portion, will, for the motion of region 16a, increase the motion of the quadrilateral structure 16 assembly at region 16b.

An alternative embodiment incorporates a spring 20 in place of the quadrilateral structure 16 as shown in Figure 4. The spring 20 has a first axis 22 and a second axis 24 (shown in phantom). The diaphragm 14 is operably attached to the spring 20 near a distal end of the second axis 24 and an armature 12 is operably attached to the spring 20 near a proximate end of the second axis 24.

It is further contemplated by this invention that an elliptical-like shaped spring 26 be used. The spring 26 can be an ellipse or a variation thereof. See Figure 5. A first axis 22 divides the spring 26 into two members 28, 30. The length of one member 28 is longer or shorter than the length of the other member 30. This embodiment is similar to the previously mentioned embodiment of the quadrilateral structure 16 having first 16e and fourth 16h portions of substantially equal and longer (or shorter) length than the length of the second 16f and third 16g portions. Analogous to the embodiment of the quadrilateral structure 16, the motion of the elliptical-like shaped spring 26 may be increased (or decreased) by differing the lengths of the members 28, 30.

While specific embodiments have been illustrated and described, numerous modifications come to mind without significantly departing from the spirit of the invention and the scope of protection is only limited by the scope of the accompanying Claims.